Z1-PU7	WYDANIE N1	Strona 1 z 3

(*faculty stamp*)

COURSE DESCRIPTION

1. Course title: CONTROL FUNDAMENTALS	**2. Course code**
3. Validity of course description: 2016/2017	
4. Level of studies: BSc programme	
5. Mode of studies: intramural studies	
6. Field of study: MACROCOURSE	(FACULTY SYMBOL)
7. Profile of studies: general	
8. Programme:	
9. Semester: 5,6	
10. Faculty teaching the course: Institute of Automatic Control, Rau1	
11. Course instructor: prof. zw. dr hab. inż. Ryszard Gessing	
12. Course classification: programme courses	
13. Course status: compulsory	
14. Language of instruction: English	
15. Pre-requisite qualifications: Calculus and Differential equations, Algebra and analytic geometry, Physics, Introduction to system dynamics. It is assumed that the student has the basic knowledge concerning linear differential equations, Laplace and Z transform, as well as the models of the systems, especially their dynamical properties.	
16. Course objectives: The objective of the lectures is to give basic control knowledge in the fields of analysis and design of linear control systems, continuous and discrete-time, single and multivariable. The objective of classes and laboratory exercises is to acquire some practice in control system analysis and design using advanced CAD environment, like MATLAB-SIMULINK	
17. Description of learning outcomes:	

Nr	Learning outcomes description	Method of assessment	Teaching methods	Learning outcomes reference code
W1	The student knows the purpose and structures of continuous and discrete automatic control systems as well as their functional components	EP	WT, WM	K_W01, K_W04, K_W20
W2	The student knows basic concepts such as stability, observability, controllability and characteristic polynomial, understands relations among them in simple and complex systems, described by state equations and transfer functions.	EP	WT, WM	K_W12
W3	The student knows how the location of roots of a characteristic equation, transfer functions and frequency responses affects the properties of control systems with respect to their transient and steady states	EP	WT, WM	K_W10
W4	The student knows types of controllers and their properties, design and realization (continuous, discrete) as well as methods of their tuning.	EP	WT, WM	K_W11, K_W12, K_W18, K_W20
U1	The student can determine the purpose of the control systems, choose their structures and is able to determine its mathematical model.	EP, SP,	C, L	K_U08, K_U09, K_U16

U2	The student can determine stability conditions for continuous and discrete systems using algebraic and frequency methods.	SP, CL	C, L	K_U07, K_U09
U3	The student is able to evaluate the quality of a control system, choose the proper structure and type of a controller and tune its parameters.	CL, PS	C, L	K_U02, K_U03, K_U04, K_U16, K_U17, K_U21
U4	The student is able to use CAD software to design a control system.	CL	C, L	K_U11
K1	The student can independently make decisions concerning the choice of acceptable and the best solutions.	CL, PS	L	K_K04, K_K05
K2	The student can present the proposed solution and justify its choice and provide arguments proving its quality.	OS	L	K_K02, K_K05

18. Teaching modes and hours

Lecture / BA /MA Seminar / Class / Project / Laboratory

Lecture: Sem 5 - 45 h./ Class: sem. 5 - 30 h/ Lab: sem. 6 – 30h

19. Syllabus description:

Lectures:

- Introduction to the course. Watt centrifugal governor Feedback Control Systems-basic notions, dynamic and static elements, block diagrams. Control system classification.
- Models of physical systems. Differential equations, state space models, linearization, transfer function for single – and multivariable elements. State space versus transfer function description. Frequency responses: Nyquist, Bode plots.
- Basic elements and their responses. Time and frequency responses of the basic elements: first order lag, second order, ideal integrator and differentiator, system with delay.
- Dynamic system properties. Fundamental matrix derivation. Canonical form. Controllability – definition, conditions. Observability – definition conditions. Stability, Hurwitz criterion.
- Feedback control systems. Voltage stabilization system. Closed-loop (CL) system description. CL frequency response – Nichols chart. Feedback system properties. Control system structure. Block diagrams transformation.
- Closed-Loop system stability. Characteristic equation of the CL system. Applying of Hurwitz criterion. Nyquist criterion, derivation and calculation usage. Stability analysis using Bode plots. Stability of the systems with delay.
- Quality of the control. Steady-state analysis – system of type 0 and type I. Account of nonlinearities. Method based on root placement. Root locus method. Methods based on integral indices. Methods based on frequency responses.
- Compensators and controllers. Lead, lag, lead-lag compensators. Recommendation for compensator choice. PID controller. Regulator implementations. Regulator parameters tuning. Ziegler-Nichols rules.
- Multivariable systems. Matrix transfer function. Stability analysis. Characteristic equation using state space and transfer function models. Applying of Hurwitz criterion. Design using the method of successive closing of control loops.
- Discrete-time systems. Z-transform. Sampling data system. Digital control systems. Discrete-time transfer function. Ideal sampler, zero-order hold, first order hold. CL system description. Stability analysis. Design.

Class exercises:

- Dynamic systems description
- Frequency responses
- Hurwitz stability criterion
- Nyquist stability criterion
- Nyquist stability criterion - systems with time delay
- Steady state analysis
- Root locus method
- Stability degree and resonance degree
- Systems quality - frequency domain methods
- Sampled data systems

Laboratory:

- CAD of control systems – Matlab introduction
- Stability of linear systems
- Static accuracy
- Phase-lead and phase-lag compensation
- Attenuation index and tracking index

- PID controllers
- Root locus method
- Sampled-data systems

20. Examination: semester 5

21. Primary sources:

1. Gessing R.: Control Fundamentals, Wydawnictwo Politechniki Śl., Gliwice 2004.

2. Franklin G.F, J.D. Powell and Emani-Naeini: Feedback control of Dynamic Systems, (Third Edition) Addison-Wesley, 1994

22. Secondary sources:

1. Phillips CL., Harbor R.D.: Feedback Control Systems (Third Edition) Prentice Hall, 1996.
2. Goodwin G.C., Graebe S.F., Salgado M.E.: Control Systems Design, Prentice Hall, 2001

23. Total workload required to achieve learning outcomes

Lp.	Teaching mode :	Contact hours / Student workload hours
1	Lecture	45/30
2	Classes	30/20
3	Laboratory	30/30
4	Project	0/0
5	BA/ MA Seminar	0/0
6	Other	10/30
	Total number of hours	115/110

24. Total hours:225

25. Number of ECTS credits: 8

26. Number of ECTS credits allocated for contact hours: 4

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 4

26. Comments:

Approved:

…………………………… *(date, Instructor's signature)*

………………………………………………… (*date , the Director of the Faculty Unit signature)*